SECRET

SECRET

OFFICE OF STRATEGIC SERVICES
Research and Analysis Branch

097.3
Z1092
No. 1500

R and A No. 1500

GERMAN AIR FORCE DEFENSIVE CAPABILITIES AND REQUIREMENTS

An examination of the results of the mounting Allied air attack on the strength of the German Air Force and on the degree to which it will be able to offer aerial opposition to Allied bombing.

DEPARTMENT OF STATE
REFERENCE DIVISION
FILE COPY
PLEASE RETURN
REF

9 November 1943

Copy No. 17

SECRET

TABLE OF CONTENTS

		Page
I.	Summary and Conclusions	1
II.	Introduction	2
III.	Projected GAF Strength and Wastage, Assuming a Constant Ratio of GAF Losses to Allied Attacks	2
IV.	Evaluation	7

TABLES AND CHARTS

Table 1. Claims of Enemy Aircraft Destroyed, April-August 1943, Western Front, by Air Forces and Types of Aircraft, and ~~Hypothetical~~ Claims, November 1943 - March 1944, Western Front and XVth USAAF (Assuming Constant GAF Opposition, and Expanding USAAF Bomber Sorties) 4a

Table 2. British Air Ministry Estimates of GAF Wastage, April-August 1943, by Fronts and by Types of Aircraft, and Hypothetical Wastage, November 1943 - March 1944 (Assuming Constant GAF Opposition and Expanding USAAF Bomber Sorties) 5a

Chart 1. Claims of German Single-Engine Fighters Destroyed April-October 1943 by British-based Aircraft, and Projected Claims, November 1943 - March 1944 (Assuming Constant GAF Opposition and Expanding USAAF Bomber Sorties) 4b

Chart 2. British Air Ministry Estimates of GAF Wastage, All Fronts, April-August 1943, by Types of Aircraft, and Projected Wastage, November 1943- March 1944 (Assuming Constant GAF Opposition and Expanding USAAF Bomber Sorties) 5b

Chart 3. British Air Ministry Estimates of German Single-Engine Fighter Wastage, Average April - August 1943, by Theaters, and Projected Wastage, November 1943 - March 1944 (Assuming Constant GAF Opposition and Expanding USAAF Bomber Sorties) 5c

GERMAN AIR FORCE DEFENSIVE CAPABILITIES AND REQUIREMENTS

I. SUMMARY AND CONCLUSIONS

The expanding strength of the air offensive against Continental Europe in the coming months will present the GAF with sharply increased defensive requirements. These requirements will so greatly exceed the present capabilities of the GAF that its opposition can be maintained at present intensity only if it will accept heavily mounting attrition. The purpose of this discussion is to relate the projected increase in the weight of the attack to GAF strength and wastage, and thereby to predict, in rough measure, the future course of the GAF.

A projection of GAF wastage into the future can be made on the basis of historical ratios between Allied bomber attacks and the destruction of GAF defenders. Allocation of heavy bombers to the VIIIth USAAF and the newly created XVth USAAF will permit a sharply increased number of daylight attacks in the next five months. A projection of wastage of German single-engine fighters, based on historical loss-ratios, shows wastage in excess of probable production. This projection is doubtless unrealistic if used to estimate future GAF numerical strength; but it indicates the magnitude of the decline that must occur either in GAF strength or in GAF opposition, since opposition and strength are complementary quantities in the sense that strength can be maintained only by reduced opposition, or opposition maintained only by acceptance of a reduction in strength.

II. INTRODUCTION

The mounting scale of USAAF bombing attack on Europe in coming months will affect the strength of the GAF in two ways: (1) bomb damage to German aircraft production facilities will reduce output of replacements for the GAF, and (2) more intense attack will require increased GAF opposition and consequently increased wastage, or, if it chooses to avoid such wastage and conserve its strength, the weaker defense will increase the effectiveness of Allied attack.

The present study treats only the second of these alternatives - the effect on GAF strength of increased wastage or dilution of opposition.

The degree of intensity of opposition to Allied bombing attack lies to some extent within the choice of the GAF. This factor makes difficult any projection of GAF wastage and strength. One assumption might be that GAF policy will require opposition to continue in its present intensity, so far as it lies within the power of the GAF to offer such opposition. An analysis of the results of this policy, in which it is expected to establish only useful orders of magnitude, is given in the first part of the present study; the second part is devoted to an examination of the validity of this assumption and its limitations.

III. PROJECTED GAF STRENGTH AND WASTAGE, ASSUMING A CONSTANT RATIO OF GAF LOSSES TO ALLIED ATTACKS

Pilots' claims as to the number of defending aircraft shot down are the only wastage statistics which can be directly related to the intensity of the bombing attack. The ratio of the number of planes claimed to be destroyed to the number of bombers attacking depends upon a number of factors - among them the depth, geographically, of the attack. For example, examination

of a number of VIIIth Air Force Bomber Command missions for the period June 11 - October 14, 1943 shows the following relationships:[1]

Type of Mission	No. of bombers dispatched		Claims of aircraft destroyed		Claims of aircraft destroyed per 100 sorties	
30 "deep" raids	4,278		1,216		28.4	
16 "medium" raids	1,643)		251)		15.2)	
		4,730		483		10.2
29 "shallow" raids	3,087)		232)		7.5)	
75 raids	9,008		1,699		18.9	

There are two reasons why the number of aircraft claimed to be destroyed mounts with the increasing depth of the attack: the deeper raid gives opportunity for more fighters to rise in opposition, and to remain longer in contact with the attacking force; and the targets deeper in the Continent are more vital targets, and are therefore defended with greater ferocity. In fact, the defense against attacks on coastal targets and airfields in Northern France has already become little more than nominal, indicating that the GAF has already adopted at least a partial policy of conservation.

The ratio of aircraft claimed to be destroyed to the number of bomber sorties has varied from month to month, but has been fairly constant during 1943. This is shown by the following summary:

Type of mission	Number of heavy bombers dispatched	Claims of a/c destroyed[2]	Claims a/c destroyed per 100 sorties
All sorties Aug-Dec 1942	1,422	102	7.2
All sorties Jan-March 1943	1,681	263	15.6
All sorties April-June	3,825	788	20.6
All sorties July-Sept	7,705	1,109	14.4
All sorties Oct 1-24	2,749	496	18.0

1. The data are from Operational Research Section Reports, VIIIth Bomber Command.
2. Preliminary claims, which are generally below final claims.

Assuming that the existing ratios, presented above, of the number of defending aircraft claimed to be shot down to the number of bombers attacking continue to hold in the face of increased bomber sorties, and given an estimate of the number and depth of future bombing sorties, it is possible to project a series of hypothetical pilots' claims into the future. Table 1 and Chart 1 show the results of such calculations. Table 1 assumes, in the case of sorties by British-based aircraft, that the casualties claimed by aircraft of the RAF and by aircraft of the VIIIth USAAF other than the Bomber Command will remain constant.[1] In the case of the projected claims by the bombers attached to the newly created XVth Air Force, no ratios of attacking planes to pilots' claims, based on previous experience, are available. A rate of fifteen defensive casualties for every one hundred deep bomber sorties has therefore been arbitrarily assumed. Table 1 and Chart 1 show a substantial increase in the projected number of pilots' claims, with claims of SEF destroyed by VIIIth USAAF Bomber Command increasing from an average of 288 during the months of April through August 1943 to 677 in March 1944, and claims of all types rising from 316 to 750. Total claims by British-based aircraft rise from 425 SEF and 507 of all types to 834 and 984 respectively.

Pilots' claims as to the number of enemy aircraft destroyed are doubtless higher than the actual number of planes destroyed. A much more conservative estimate of GAF wastage is that made by the British Air Ministry. Although the BAM estimate is probably an understatement of the actual wastage, at least on the Western Front, it may be nearer the truth than are pilots' claims. The BAM also gives estimates for wastage on other fronts, and a total wastage estimate, which can be compared with production data. Current

1. At the average level achieved between September 6 and October 24.

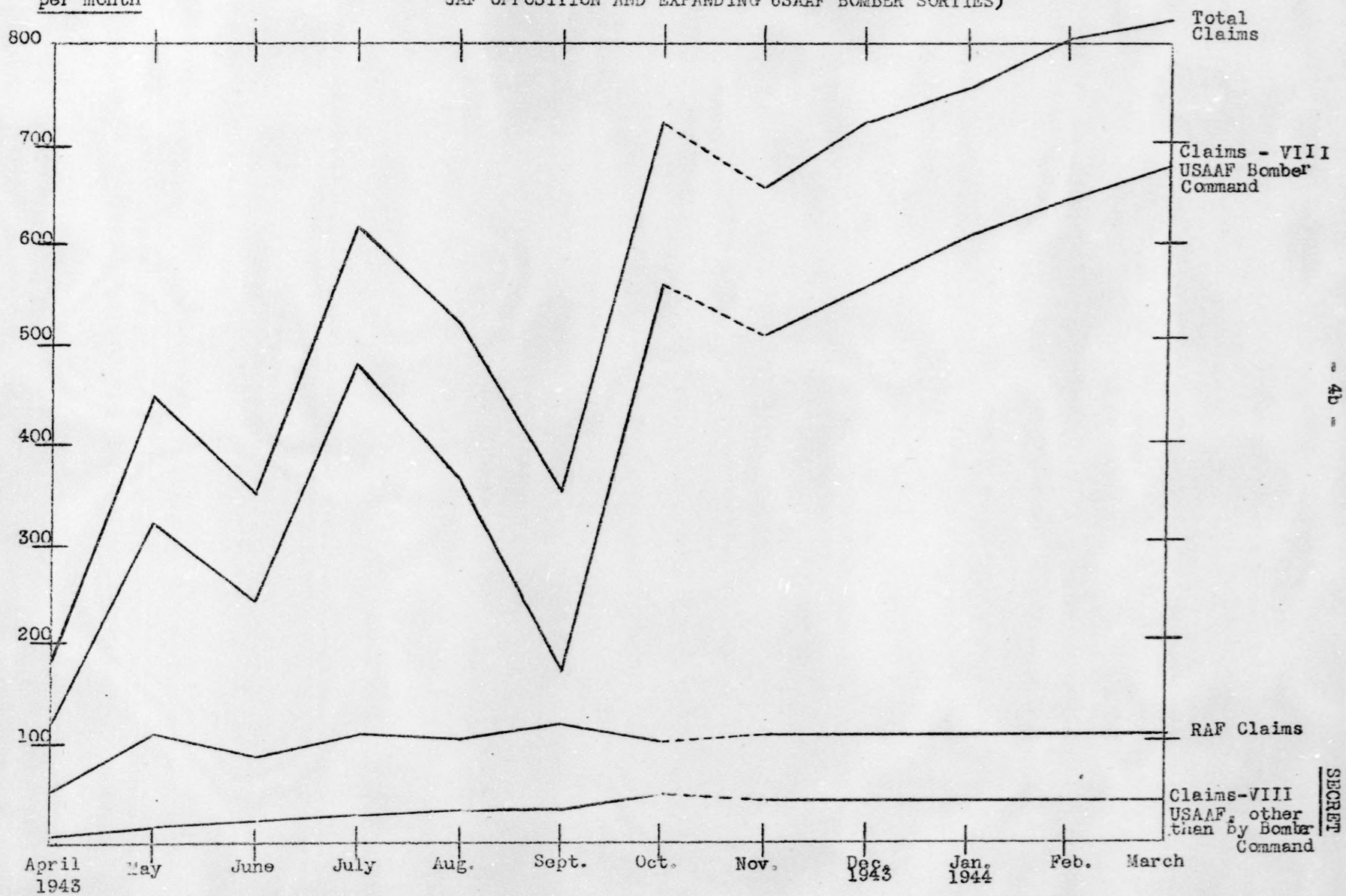
Table 1. CLAIMS OF ENEMY AIRCRAFT DESTROYED, April-August 1943, WESTERN FRONT, BY AIR FORCES AND TYPES OF AIRCRAFT, AND PROJECTED CLAIMS, November 1943 - March 1944, WESTERN FRONT AND XVth USAAF, (Assuming Constant GAF Opposition, and Expanding USAAF Bomber Sorties)

Period	Hypothetical Future Sorties: VIIIth USAAF Bomber Command "Deep"	Hypothetical Future Sorties: VIIIth USAAF Bomber Command Other	Hypothetical Future Sorties: XVth USAAF "Deep"	Projected Claims, Western Front: Type of aircraft destroyed	VIII USAAF Bomber Command	RAF and other VIII USAAF	Total	Projected claims XV USAAF[1]	Total projected claims, Western Front and XV USAAF
Average, April-Aug. 1943				SEF	288	136	424	0	424
				TEF	28	26	54	0	54
				All	316	191	507	0	507
Projected, November 1943	1440	1500	360	SEF	509	157	666	47	713
				TEF	51	50	101	7	108
				All	563	234	797	54	851
Projected, December 1943	1620	1670	720	SEF	566	157	723	95	818
				TEF	57	50	107	14	121
				All	590	234	824	109	933
Projected, January 1944	1740	1810	840	SEF	607	157	764	109	873
				TEF	61	50	111	17	128
				All	672	234	906	126	1,032
Projected, February 1944	1860	1940	960	SEF	649	157	806	125	931
				TEF	65	50	115	19	134
				All	717	234	951	144	1,095
Projected, March	1920	2000	1140	SEF	677	157	834	149	983
				TEF	67	50	117	23	140
				All	750	234	984	172	1,156

1. In addition to present claims by Mediterranean-based aircraft.

SECRET

Chart 1. CLAIMS OF GERMAN SINGLE-ENGINE FIGHTERS DESTROYED April-October 1943 BY BRITISH-BASED AIRCRAFT, AND PROJECTED CLAIMS, November 1943 - March 1944(ASSUMING CONSTANT GAF OPPOSITION AND EXPANDING USAAF BOMBER SORTIES)



SECRET

BAM estimates of GAF wastage can be projected into the future by assuming that the proportion of the wastage presently estimated to be due to USAAF bomber attacks will increase by the same percentage as the projected pilots' claims shown in Table 1, while wastage on other fronts will continue unchanged.[1] The resulting projections of the BAM series are shown in Table 2 and in Charts 2 and 3. The increase in the projected total wastage is of course much less, proportionally, than the increase in pilots' claims, but it is substantial, showing a rise of SEF wastage from 612 per month in the period April - August 1943 to 773 in March 1944, and total wastage increasing from 1,264 to 1,531 in the same period.

On the basis of the hypothetical wastage series derived above, it is possible to project the strength of the GAF into the future, on the basis of several sets of assumptions:

A. Assuming (1) that the projected BAM wastage series shown above is broadly correct, (2) that the present production rates of SEF and TEF are 600 and 220 per month respectively, and that production will be kept at these levels through the effects of continued bombing, and (3) that present strength of the GAF in SEF and TEF is 1,565 and 1,020 respectively, the following would be the projected strength of the GAF over the next five months:

	SEF			TEF		
	Strength at beginning	Production	Wastage	Strength at beginning	Production	Wastage
November	1,565	600	697	1,020	220	175
December	1,468	600	725	1,065	220	186
January	1,343	600	742	1,101	220	191
February	1,201	600	760	1,130	220	196
March	1,041	600	773	1,154	220	201
April	868			1,173		

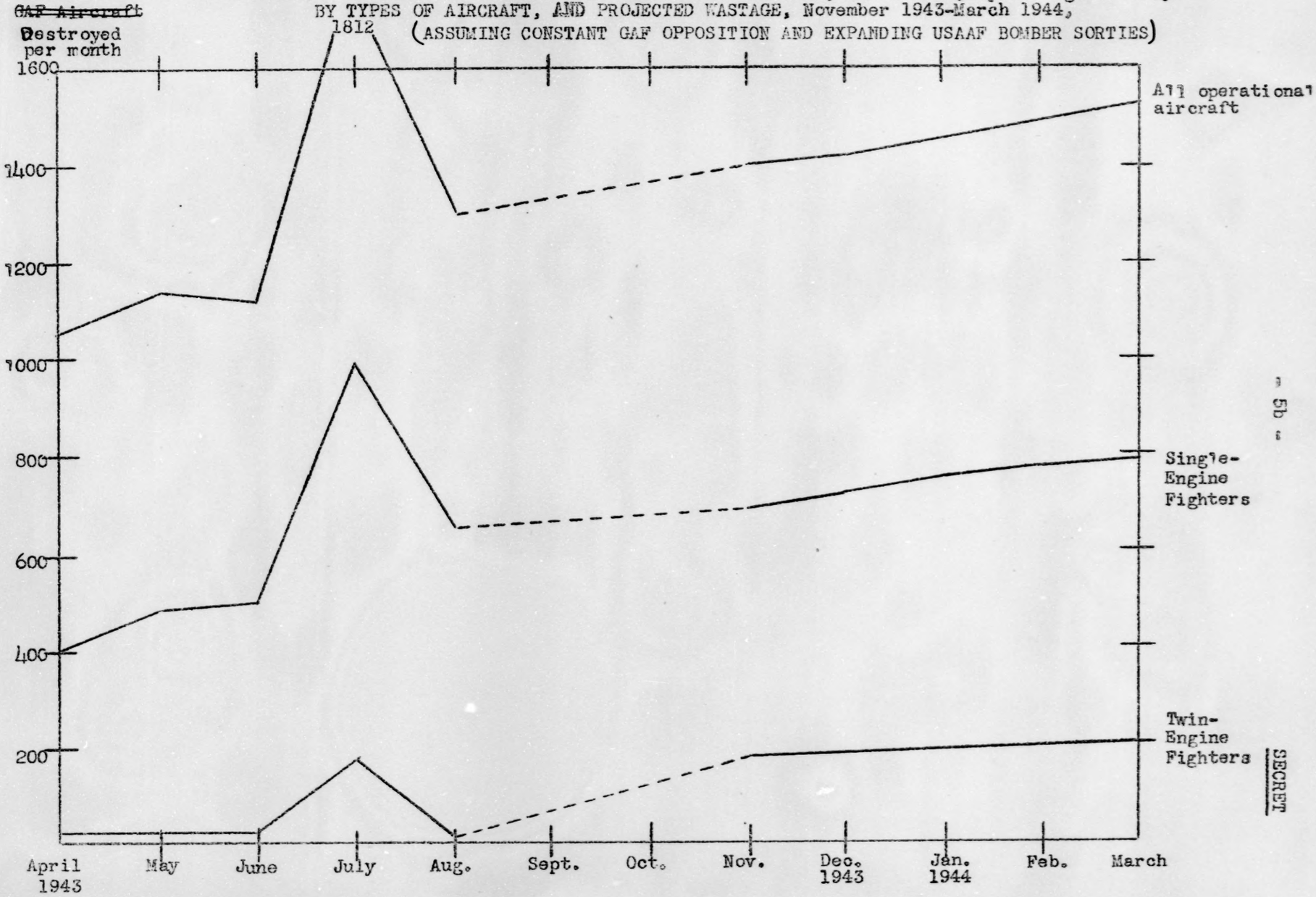
1. Wastage on the Mediterranean front is assumed constant, except for the additional wastage attributable to the "deep" sorties of the XV USAAF (at the rate of 15 enemy planes claimed per 100 deep sorties, reduced by the same correction factors as were applied to VIII USAAF claims).

Table 2. BRITISH AIR MINISTRY ESTIMATES OF GAF WASTAGE, APRIL-AUGUST 1943, BY FRONTS AND BY TYPES OF AIRCRAFT, AND HYPOTHETICAL WASTAGE, NOVEMBER 1943-MARCH 1944 (ASSUMING CONSTANT GAF OPPOSITION AND EXPANDING USAAF BOMBER SORTIES)

Period	Type of airdraft	Western Front	XVth USAAF	Other Mediterranean	Eastern Front	Central Germany	Total
Average April-August 1943	SEF	123	0	244	159	86	612
	TEF	44	0	28	32	26	136
	All	209	0	359	497	199	1,264
Projected November	SEF	194	14	244	159	86	697
	TEF	83	6	28	32	26	175
	All	328	23	359	497	199	1,406
Projected December	SEF	209	27	244	159	86	725
	TEF	88	12	28	32	26	186
	All	339	44	359	497	199	1,438
Projected January 1944	SEF	221	32	244	159	86	742
	TEF	91	14	28	32	26	191
	All	373	51	359	497	199	1,479
Projected February	SEF	233	38	244	159	86	760
	TEF	94	16	28	32	26	196
	All	391	60	359	497	199	1,606
Projected March	SEF	241	43	244	159	86	773
	TEF	96	19	28	32	26	201
	All	405	71	359	497	199	1,531

SECRET

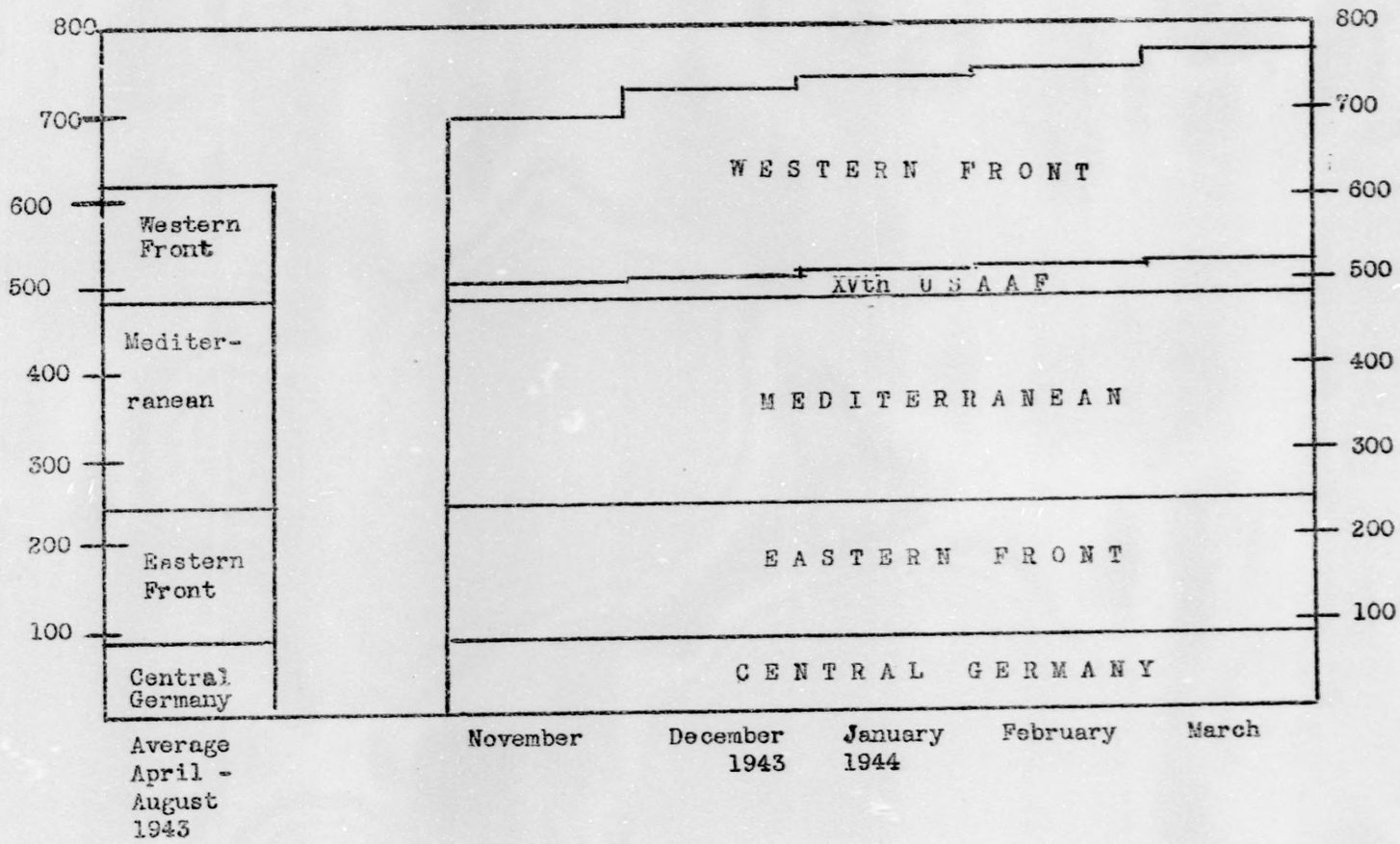
Chart 2. BRITISH AIR MINISTRY ESTIMATES OF GAF WASTAGE, ALL FRONTS, April-August 1943, BY TYPES OF AIRCRAFT, AND PROJECTED WASTAGE, November 1943-March 1944, (ASSUMING CONSTANT GAF OPPOSITION AND EXPANDING USAAF BOMBER SORTIES)



5b

SECRET

Chart 3. BRITISH AIR MINISTRY ESTIMATES OF GERMAN SINGLE-ENGINE FIGHTER WASTAGE,
AVERAGE April - August 1943, by THEATERS,
AND PROJECTED WASTAGE, November 1943 - March 1944,
(ASSUMING CONSTANT GAF OPPOSITION AND EXPANDING USAAF BOMBER SORTIES)



SECRET

B. Assuming (1) that the projected BAM wastage series shown above is broadly correct, (2) that production of SEF and TEF will decline from present levels through the effects of continued bombing in the manner shown below, and (3) that present strength is 1,565 SEF and 1,020 TEF, the projection would be as follows:

	S E F			T E F		
	Strength at beginning	Production	Wastage	Strength at beginning	Production	Wastage
November	1,565	520	697	1,020	210	175
December	1,388	450	725	1,055	195	186
January	1,113	425	742	1,064	125	191
February	796	400	760	998	125	196
March	436	400	773	927	125	201
April	63			851		

C. Assuming (1) that present production is understated by the BAM and that monthly production is, and will continue to be, 800 SEF and 250 TEF, (2) that pilots' claims, as calculated above, are an accurate measure of wastage on the Western Front, and therefore that total wastage will increase in the manner shown below, and (3) that present strength is 1,565 SEF and 1,020 TEF, projected strength is as follows:

	Strength at beginning	Production	Wastage	Strength at beginning	Production	Wastage
November	1,565	800	1,202	1,020	250	200
December	1,163	800	1,307	1,070	250	213
January	656	800	1,362	1,107	250	220
February	94	800	1,420	1,137	250	226
March				1,161	250	232
April				1,179		

All of the above calculations are unrealistic in that they show no correlation of SEF and TEF strength. Obviously, as SEF strength declined, TEF would be thrown into the breach, moderating to some extent the decline in

SEF strength, and accentuating the decline in TEF. The orders of magnitude involved in the various assumptions, however, are illustrative.

IV. EVALUATION

An attempt to assess the validity of these projected wastage and strength series requires an analysis of the assumptions on which they are based.

The major assumption made in the above analysis is that GAF losses to USAAF bombers will continue to bear the same ratio to the weight of the USAAF attack as has obtained in the past. Aside from the question of GAF High Command intentions (which might be to conserve strength by reducing the scale of opposition to bombing attacks), is it reasonable to assume that GAF losses could continue to bear a fixed relationship to the weight of the attack? The continuation of the present relationship into the future in the face of sharply increased attacks would require an increase either in the ratio of GAF defensive sorties to GAF strength or in the ratio of GAF losses to GAF defensive sorties, or in both. Are such increases reasonable to expect?

The increase in USAAF deep attacks, which account for the larger portion of its claims, will not take place by an increase in the number of days per month on which such attacks will occur (except that new Mediterranean based bombers may be able to operate more frequently than British-based), but it will occur largely through an expansion in the number of bombers attacking on the few days of good weather. This larger number of bombers will make possible a larger number of bombers per target, and, more important, the attack on multiple targets on the same penetration. To the extent that the bombers cover a larger area, their presence can call forth a

somewhat larger number of GAF defensive sorties. However, the extensive mobility of the German fighter-screen has permitted the concentration of fighters from large areas against a single deep attack; an increase in the number of targets attacked may not increase the number of defensive sorties so much as it will reduce the number concentrated in defense of any one of the targets. If the attack on multiple targets decreases the possible concentration of fighters against any single attacking group and the number in each attacking group increases, it is reasonable to expect either a decline in the efficiency of the defense, or an increase in the loss rate per sortie of the defenders. This assumes, of course, that increased effectiveness of German defensive weapons will be offset by improved offensive weapons and tactics. Whether or not this is correct cannot be judged in advance.

Thus, the basic assumption that GAF losses to USAAF bombers might increase pari passu with the number attacking is not too unreasonable, within moderate limits. If, however, the result of this projection is a substantial decrease in GAF strength, the assumption soon becomes untenable. With declining strength, the number of GAF defensive sorties cannot increase in even partial conformity with the increase in Allied sorties, and GAF losses cannot therefore keep pace with the growing weight of the attack. The increasing disparity between Allied and GAF strength must then be felt, not in a continually mounting toll of GAF planes, but in a substantial weakening of GAF opposition.

The calculation of GAF wastage on the assumption that the part of it due to USAAF strategic bombing attacks will increase in proportion to the increasing weight of the attacks is therefore not valid for the purpose of predicting the future numerical strength of the GAF. It does have, however,

another useful purpose. GAF wastage is a convenient and roughly accurate measure of GAF opposition. To the extent that opposition continues in its same intensity, GAF wastage will increase roughly in the manner shown; to the extent that GAF wastage fails to increase in that manner, the intensity of opposition declines. To say that the GAF has some option, and can choose to avoid wastage and conserve its strength, is somewhat misleading. It can, in the long run, avoid wastage only by complete capitulation. If it prefers to avoid opposition (and wastage) now, in favor of opposition (and wastage) later, the opportunities for strategic bombing are enhanced, although the air opposition to ground invasion may be strengthened. Thus we can calculate the wastage consequent upon constant opposition, or the opposition consistent with any given wastage. The wastage series calculated above on the assumption of constant opposition is doubtless a limiting and unreal case. A reasonable limiting case, on the other extreme, is the assumption of the conservation of strength to such a degree that wastage will only equal production. But if wastage is thus arbitrarily limited, opposition cannot increase in ratio to the mounting intensity of attack. The dilution in opposition can then be measured by determining the percent by which this limited wastage, held to the level of production, falls short of the wastage which would be incurred if opposition had been in constant ratio to weight of attack. This calculation for SEF is indicated in the following table, which shows first the wastage which would be incurred if opposition were in constant ratio to weight of attack, then assumed production, which would also be the level at which wastage would be held, and finally the percent of dilution of opposition in which such a limitation of wastage would result.

Month	Wastage with constant opposition	Assumed production		Resulting dilution of opposition (percent)	
		A	B	A	B
November	697	600	520	14	25
December	725	600	450	17	38
January	742	600	425	19	43
February	760	600	400	21	47
March	773	600	400	22	48

These percentage reductions of opposition are, of course, overall reductions, and the GAF could choose how the reduction should be allocated. The reduction might, for instance, be achieved by concentrating all effort against deep penetrations against targetsin Germany, abandoning all opposition to shallow raids, and all use of fighters to support ground operations or to escort GAF bombers and dive bombers.

The problems which would face the GAF in the pursuit of such a policy of conservation are obvious, and, in the face of present German commitments, would appear to be almost insurmountable.

A further possibility is that the rate of loss per defensive sortie may increase with a decline in the number of sorties, because a weaker opposition may be less economical than a stronger one. For example, if 50 fighters are sent against 200 bombers, the loss rate per fighter sortie may be higher than if 150 fighters were thrown into the attack. If this is the case, as it may well be, the actual opposition, in terms of defensive fighter-sorties, may have to be reduced even more than the above figures indicate, if wastage is to be kept equal to production. It is even conceivable that, as the ratio of the number of defensive fighter-sorties to the number of bomber-sorties

decreases, the actual number of fighters lost will increase. For example, of 50 fighters opposing 200 bombers, 30 may be destroyed, as compared with only 20 when 150 fighters are put into the air. If this were the case, strength could be conserved only by the abandonment of all opposition.

In summary, it is apparent that the increasing scale of the USAAF bomber offensive will force the GAF either to reduce substantially its opposition to daylight bombing attacks; or to incur SEF wastage at a rate which would shortly reduce it to impotence, especially if further bombing attacks on SEF plants should reduce production below current levels. Actually, the GAF will probably neither be utterly destroyed in the next five months, nor will its opposition disappear. A substantial decline in SEF strength, perhaps to 1,000 or 1,200 by 1 April, may reasonably be expected, together with perhaps a 10 percent overall decline in the degree of opposition as measured in terms of GAF wastage per offensive bombing-sortie. This decline in opposition would be secured principally by the complete disappearance of opposition to shallow raids and to raids on unimportant German targets, with opposition to deep raids on significant targets only slightly reduced.

At some stage in any conflict an increasing disparity in strength between attack and defense becomes cumulative, and opposition crumbles; but whether the GAF will reach this stage in the next five months is problematical.

OSS - RAA No. 1500 0.13

Air Forces Ger S:11

Hoot U.K. Air Ministry S:3

Air Forces U.S. S:11

" " U.K "